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SINGLE SURFACE TREATMENT OR DUST CONTROL ON GRAVEL ROADS?

MATERIALS INFORMATION

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SINGLE SURFACE TREATMENT OR DUST CONTROL ON GRAVEL ROADS?

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BITUMINOUS SECTION

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ABSTRACT

The cost of maintaining gravel roads have increased significantly in recent years. Surveys carried out in Ontario and elsewhere in Canada indicated that overall costs could be reduced by placing a single surface treatment as the riding surface. The break-even point was estimated by MTO to be reached if the surface treatment provided about two years of service. In order to verify this suggestion, a trial was initiated in 1987 to place a number of single surface treatment test sections on township roads and compare the performance and maintenance costs for these roads with adjacent sections of gravel roads. Six townships volunteered their involvement in this project and a total of eight sections of single surface treatment were constructed and monitored. All sections continue to provide satisfactory service. Three sections required retreating following the first winter: - two sections because of failures in the grade and one section due to the use of oversize aggregate. One section required retreating in 1990.

This report describes the construction of the test sections and the findings up to the fall of 1990. In addition, the discussion also includes some observations pertaining to the environmental impact of maintaining a network of gravel roads. It is recommended that the use of single surface treatment be considered as a viable means of dust abatement. Life expectancy of the surface treatment is strongly dependent on the quality of the grade and provision of adequate drainage.

RÉSUMÉ

Ces dernières années, les coûts d'entretien des routes de gravier ont considérablement augmenté. Des études effectuées en Ontario et ailleurs au Canada ont démontré que les coûts globaux pouvaient être réduits en appliquant un revêtement superficiel simple sur la chaussée. Le MTO a estimé que le seuil de rentabilité serait atteint si le revêtement superficiel durait environ deux ans. Pour vérifier cette affirmation, on a amorcé une étude en 1987 qui consistait à appliquer un revêtement superficiel simple sur des tronçons de routes de canton et à comparer l'efficacité et les coûts d'entretien de ces routes avec ceux des tronçons de routes de gravier adjacentes. Six cantons ont bien voulu participer à ce projet et le traitement a été appliqué à huit tronçons qui continuent à donner entière satisfaction. On a dû répéter le traitement sur trois tronçons à la suite du premier hiver, sur deux tronçons en raison de la mauvaise qualité de l'enduit et sur un tronçon parce qu'on avait utilisé des agrégats trop gros. Par ailleurs, un tronçon a dû être traité à nouveau en 1990.

Le présent rapport décrit le traitement des tronçons mis à l'essai et les résultats obtenus jusqu'à l'automne de 1990. Il comporte aussi des observations sur les retombées environnementales de l'entretien du réseau de routes de gravier. On y recommande d'envisager l'utilisation d'un revêtement superficiel simple comme moyen de réduire la poussière. La durée du revêtement superficiel est grandement tributaire de la qualité de l'enduit et d'un bon drainage.

1. INTRODUCTION

A paper presented at the 1986 Canadian Technical Asphalt Association meeting entitled: "Performance of Bituminous Surface Treatments in Northern Canada" evaluated the performance of single surface treatments applied on prepared granular grades in the Yukon. The paper compared the cost of applying a single surface treatment using a graded aggregate and a high float emulsion applied once over an existing granular grade with the cost of maintaining a similar grade using grader maintenance, aggregate replacement and dust control on an annual or as needed basis. The analysis indicated that an economic break-even point would be reached if the single surface treatment provided three years of service.

Studies carried out by MTO in December 1986 indicated that similar or better experience could be expected in Ontario. The Bituminous Section estimated a cost of $6,100 per km of 6.7 m wide single surface treatment. Huntsville District estimated that the cost for the maintenance of gravel roads was about $2,630 per km. This cost was confirmed by the Maintenance Management Section who indicated an average cost for maintaining gravel roads across the Province of $2,935 per km. Thus an economic break-even point of about two years for a single surface treatment could be expected if these costs were correct. Seymour Township in Northumberland County had achieved over five years of service from this treatment where the grade was "half-way decent".

A project was initiated in the spring of 1987 by the Bituminous Section, Engineering Materials Office in co-operation with the Municipal Roads Office to determine if comparable performance could be achieved in practice using MTO Material and Construction specifications. If the single surface treatments provided in excess of two years of service, considerable savings could be anticipated.

2. TEST SECTIONS

2.1 Guidelines

Six municipalities volunteered participation in this project providing a variety of geographical areas, granular road surfaces and traffic volumes. Each municipality was asked to provide test sections approximately 1 km long for the single surface treatment and an equal length for the application of a dust suppressant of their choice. Locations were to be adjacent to each other where practical.

The evaluation was expected to continue for a period of four years from 1987 to 1990 inclusive. Each municipality received $20,000.00 in supplementary funding for use in the initial application of the single surface treatments.

2.2 Materials

The following types of materials were used in the field trials:

1. Single Surface Treatment comprising of:
   (a) High Float emulsions, HF150S or HF250S grades, conforming to Ontario Provincial Standard Specification (OPSS) 1103.
   (b) Class 2 Aggregate (a graded aggregate) conforming to OPSS 304.
2. Calcium Chloride - Liquid or flake.
3. Waste Oil - A combination of used petroleum products.
4. Black Liquor - A lignosulphonate derivative.

3. CONSTRUCTION

Grade preparation, equipment inspection and the materials application was supervised by the staff of the township involved. The recommended materials and application rates as used in the single surface treatments were as follows:

a) 1.80 kg/m^2 of HF-150S or HF250S emulsion;
b) 19 kg/m^2 of Class 2 aggregate.

The application rates for the various dust suppressants were determined in the field by the township staff, based on the requirements of the individual test sections.

4. PERFORMANCE MONITORING

Each test section was monitored on an annual basis by the township road staff involved. Performances were noted on the reporting forms provided by the MTO along with the annual maintenance costs. Copies of the reporting forms are given as Fig. 1 and 2 for the surface treatment and dust suppressant trial sections respectively. In addition, site surveys were conducted by staff of the Bituminous Section in the fall of 1988 and in the fall of 1990.

A numerical rating system using the Surface-Treated Pavement Condition Evaluation Form (Fig. 3) was employed to assess the condition of each test section. This pavement condition rating was then matched with the appropriate pavement condition described in the form "A Guide for Estimation of Pavement Condition and Associated Maintenance Rehabilitation Strategies for Surface-Treated Roads" (Fig. 4) to arrive at a condition rating and a Riding Comfort Rating. These ratings are most suitable for the surface treated sections but were adapted for the dust suppressant sections as well.

5. TEST SECTION LOCATIONS

The following sections of road were used in the trials. SST indicates that a single surface treatment was applied. DS indicates the application of a dust suppressant.

SECTION	MUNICIPALITY	LOCATION	AREA	TREATMENT
1	Township of Hinchinbrooke	Oak Flats Road Lot 22 & 23, Con.4	Length 1.0 km Width 5.48 m	SST
2	"	Wagarville Road Lot 24, Con.6	Length 1.0 km Width 6.10 m	SST
3	"	Wagarville Road Lot 24, Con.7	Length 1.0 km Width 4.88 m	DS
4	"	White Lake Road Road Allowance between Lots 10 & 11, Concession 1	Length 1.0 km Width 4.88 m	DS

Test Section Locations (Continued)

SECTION	MUNICIPALITY	LOCATION	AREA	TREATMENT
5	Township of Hagarty & Richards	Hagarty Road No. 16 W. of Highway 62	Length 1.1 km Width 6.7 m	SST
6	"	Hagarty Road No. 19 E. of Highway 62	Length 0.9 km Width 6.7 m	SST
7	"	Hagarty Road No. 16 W. of Highway 62	Length 0.5 km Width 6.1 m	DS
8	"	Hagarty Road No. 19 E. of Highway 62	Length 0.5 km Width 3.65 m	DS
9	Town of East Gwillimbury	Holborn Road Con.7 to Highway 48	Length 2.0 km Width 6.75 m	SST
10	"	Holborn Road Con. 6 to 7	Length 2.0 km Width 6.75 m	DS
11	Town of Newcastle	Con. Road 10 Jct. of Hwy. 35 Westerly & 3.05-3.60 km W. of Jct. Hwy. 35	Length 2.0 km Width 7.3 m Length 0.55 km Width 7.3 m	SST
12	"	Con. Road 10 2.0 - 3.05 km W. of Jct. Hwy. 35	Length 1.05 km Width 6.1 m	DS
13	Township of Glanbrook	Kirk Road West Trinity Church Rd. to Fletchers Road	Length 1.1 km Width 6.5 m	SST
14	"	Haldibrook Road Tynside Road to Con.8, Lot 7	Length 2.7 km Width 7.0 m	DS
15	Town of Caledon	1st line East 25th Side Road to Hwy. 9	Length 2.5 km Width 7.0 m	SST
16	"	1st line East 20th Side Road to 25th Side Road	Length 3.0 km Width 7.0 m	DS

6. SUMMARY OF FINDINGS

The following Table summarizes the costs and the observations from the site inspections. Further details are presented in the Appendix.

SECTION	TOTAL COST per km per year	TREATMENT	SUMMARY OF OBSERVATIONS
1	$1,934.33 (4 years)	SST	Satisfactory performance. Good coarse aggregate retention and riding qualities.
2	$2,568.08 (3 years) (1988 - 1990)	SST	Fair performance. Retreated with SST in '88 due to grade failure. Riding qualities affected by washboarding, distortion and patching.
3	$4,168.80 (2 years) (1987 - 1988)	DS	Field performance not possible. Natural Brine dust suppressant used initially, then calcium chloride. Double Surface Treatment applied in '89.
4	$2,424.62 (4 years)	DS	Generally good performance on low traffic volume road. Flake and liquid Calcium Chloride dust suppressant used.
5	$4,062.23 (4 years)	SST	Satisfactory surface treatment. Patching and slight rippling has affected quality of ride.
6	$4,073.94 (4 years)	SST	Satisfactory surface treatment. Amount of patching indicates weakness in the grade.
7	$3,325.25 (4 years)	DS	Satisfactory performance. Road Oil suppressant lasted until 1990 when liquid calcium chloride was applied. Costs include lift of granular.
8	$888.13 (4 years)	DS	Good performance. Road Oil suppressant lasted until 1990 when liquid calcium chloride was applied.
9	$3,712.37 (3 years) (1987 - 1989)	SST	Fair performance. Retreated with SST in 1990 following failure of original surface. Oversize stone has affected the performance of this section.

....Cont'd.

Summary of Findings (Continued)

SECTION	TOTAL COST per km	TREATMENT	SUMMARY OF OBSERVATIONS
8	$888.13 (4 years)	DS	Good performance. Road Oil suppressant lasted until 1990 when liquid calcium chloride was applied.
9	$3,712.37 (3 years) (1987 - 1989)	SST	Fair performance. Retreated with SST in 1990 following failure of original surface. Oversize stone has affected the performance of this section.
10	$3,196.57 (4 years)	DS	Generally poor performance. Liquid Calcium dust suppressant used. Possibly inadequate grading. Costs include lift of granular in 1990.
11	$2,345.53 (4 years)	SST	Fair performance. Oversize stone in the cover aggregate and moderate patching has affected the riding quality.
12	$411.19 (4 years)	DS	Satisfactory performance. Flake calcium chloride was used as the dust suppressant.
13	$3,845.04 (3 years) (1988 - 1990)	SST	Satisfactory performance. Break-up due to use of oversize stone after first winter. Retreated with SST which is now giving adequate service with minimum maintenance.
14	$1,079.34 (4 years)	DS	This section performed well until a double surface treatment was applied in 1988. Liquid Calcium chloride dust suppressant was used. Costs for similar gravel roads were used in the analysis.
15	$3,000.00 (3 years) (1988 - 1990)	SST	Poor performance. Retreated with SST after the first winter. Extensive maintenance required due to poor drainage conditions but costs of maintenance are not available.
16	$1,020.26 (4 years)	DS	Generally good performance. Liquid Calcium dust suppressant used.

Cost Summary - All data included:

SST	Average Cost per km per year	=	$3,193
	Range	=	$1,934 to $4,074
DS	Average Cost per km per year	=	$2,064
	Range	=	$411 to $4,169

However, it is clear that some of the Total Costs reported were atypical or are no longer valid. Sections 7 and 8 used Road Oil as the dust suppressant. It is no longer permissible to use this material because it was banned by the Ministry of the Environment in January 1989 and thus the costs should not be included in the cost analysis. Section 12 indicated Total Costs per km per year of only $411.19. This is very low compared to the average costs suggested by Huntsville District and the Maintenance Management Section as typical for the cost of maintaining gravel roads. The costs for Section 12 are therefore not included. No maintenance costs are available for Section 15 and therefore the Total Cost for this section is not reliable and has been excluded.

Cost Summary - Revised Data (Sections 7, 8, 12 and 15 excluded)

SST	Average Cost per km per year	=	$3,220
	Range	=	$1,934 to $4,074
DS	Average Cost per km per year	=	$2,508
	Range	=	$1,020 to $4,169

This analysis indicates that the cost difference between the two types of surfaces is very small. However, there are other tangible benefits from the use of single surface treatments which are not related simply to the maintenance of the road.

1. The loose stone (or "float") on the surface of gravel roads is kicked up by the passage of traffic and causes damage to other vehicles using the road. Broken windshields, broken headlamps and paint damage are frequently caused by loose float. As traffic volumes have increased on gravel roads the likelihood of this damage occurring has also increased. This cost is not incurred on surface treated roads. Loose float also reduces the control a driver has over his vehicle and therefore has safety implications.

2. Lost cover aggregate has to be replaced from time to time. The depletion of quality aggregate sources, the escalating costs of replacing granular materials and the introduction of "sustainable development" requirements make it very difficult for many townships to maintain their gravel road system to a high standard.

3. Fine particles become airborne with the passage of traffic and create dust clouds which can be a safety hazard to traffic and are environmentally undesirable. Traditional methods of reducing the above mentioned problems involved applications of some form of dust suppressant on an as-required basis but these do not eliminate the problem entirely. These products, such as liquid or flake calcium chloride and others of a proprietary nature, are designed to create a crust which acts as a riding surface and bonds the aggregate together. Waste oil was widely used as a means of controlling dust until it was banned in 1989. Dust is not a problem on surface treated roads.

7. CONCLUSIONS

7.1 All of the original 8 surface treatments constructed for this trial are still in service and are providing adequate performance.

7.2 However, four Single Surface Treatment Sections (Sections 2, 9, 13 and 15) required re-treatment

(a) Two surface treatments required retreating after the first winter due to grade failure (Sections 2 and 15). Costs for these sections are based on the three years following the re-application of the surface treatments in 1988.

(b) One surface treatment (Section 9) lasted two years and required retreating due to spring-break up in the winter of 1989-90. It was re-applied in 1990. Costs for this section are based on the three years performance from 1987 to 1989.

(c) One surface treatment required retreating after the first year due to the use of off-specification cover aggregate used (Section 13). Costs for this section are based on the three years following the re-application of the surface treatment.

7.3 Two of the Dust Suppressant Sections (Sections 3 and 14) were surface treated as part of a surfacing programme.

7.4 The performance of the single surface treatment sections was dependent on the quality of the materials and the condition of the grade on which it was placed.

8. DISCUSSION

It is possible to identify a number of advantages and disadvantages for the use of either type of surfacing. Some of these are clearly established from the performance of the sections used in this trial. It should be noted that no allowance has been made in the cost analysis of the trial sections for the cost of financing the Capital Investment needed to fund the surface treatment option.

8.1 The annual costs per km of maintaining gravel roads is slightly less than the costs for single surface treatment averaging $2,508 versus $3,220 in the trial sections assessed. However, the cost of a single surface treatment would likely be reduced over a period of time greater than three years. Past experience has shown that most surface treatments perform well enough such that only distressed areas need be re-treated and the remainder of the surface treatment can last for several years thus reducing the average cost per year.

8.2 Good performance has been experienced for many years using Waste Oil as a dust layer. Waste Oil behaves differently from dust palliatives, binding the aggregate particles together and, as it is not water soluble, remains within the road structure. Re-treatment may only be required every three or four years. This material was banned from use in January 1989. Sections 7 and 8 were treated with Waste Oil in 1987 and this lasted until 1990 before another treatment became necessary.

8.3 The following comparison between the two surfaces is drawn from knowledge gained over many years of experience with these materials.

	Gravel Surfaces	Surface Treatments
a)	Gravel roads require the addition of new granular material from time to time to replenish cover aggregate which is lost by traffic, grader maintenance and snow plows. The frequency with which this replacement is required varies from 1 to about 5 years and is largely dependent on traffic volumes.	Surface treatments do not consume aggregate sources on an on-going basis. Material is not lost to the ditches and shoulders.
b)	The continuing consumption of a non-renewable resource (i.e. gravel aggregate) does not comply with "sustainable development" requirements.	Surface treatments do not drain aggregate resources
c)	Even well maintained gravel roads produce a small amount of airborne pollution. The effectiveness of the application deteriorates between applications, being fairly good immediately after placement to almost ineffective. The safety of the road user is therefore at some risk. The township staff are always under pressure to preserve funds and thus an application is delayed for as long as possible. With increasing emphasis being placed on the environment, this may no longer be considered acceptable.	Surface treatments are dust free soon after placement.
d)	Township staff are loth to apply dust suppressant at the end of the summer. Thus, if the fall is dry the dust problem can be significantly higher at this time of the year.	Surface treatments are dust free all year.
e)	Dust suppressant "crusts" cannot tolerate the effects of a heavy rain storm which usually occur at least once each year. Vehicles travelling on the saturated surface disturb the granular materials and break up the riding "crust". It may not be possible to carry out the necessary re-grading and re-treatment immediately and thus the performance of the road is reduced.	Surface treatments provide a tough waterproof membrane to the surface of the road and are not damaged by heavy rain storms.

f)	Any dust suppressant applied will eventually be leached from the road surface and end up somewhere in the ground water system. This problem led to the ban of Road Oil in January 1989 and requires the careful handling of all products used as dust suppressants.	Surface treatments do not leach.
g)	Gravel roads can deteriorate to unacceptable levels during spring break-up.	A surface treatment will provide a year-round riding surface.
h)	Gravel roads in general do not exhibit as good riding qualities as roads with an all weather surface and this can greatly affect vehicle operating costs. Maintenance costs and fuel consumption increase as the rideability decreases.	The quality of ride provided by surface treatments created a noticeable increase in the volume of traffic using the SST sections during the course of the trials. Drivers, who previously did not have a choice between gravel roads and SST roads, will always favour the latter thus increasing the loadings on the SST sections.
i)	The presence of loose float on the surface of the road can be hazardous to the road user. This coarse aggregate tends to form windrows of loose gravel which can cause lack of control, especially with today's smaller cars.	Surface treatments provide a safe driving surface.
j)	Maintenance staff in the townships are comfortable with the techniques of dust suppressant and grader maintenance which have been in use for many years.	A move to a more extensive use of surface treatments in the townships will require the acquisition of a new set of skills by the staff involved. They will be required to become knowledgeable about the construction and maintenance of surface treated roads. If surface treatment is adopted as an alternative, training requirements must be satisfied. An appropriate training plan must be developed and delivered.

9. RECOMMENDATIONS

9.1 The difference in annual costs between the two road surface systems is small. It is therefore recommended that the use of a single surface treatment be considered as a viable alternative to the maintenance of gravel roads with dust suppressants.

9.2 For best performance, single surface treatments should be constructed using current OPSS construction and materials specifications.

9.3 Where single surface treatments are to be applied, the grade should be prepared to a reasonable standard. Any major defects should be repaired; e.g. known major frost boils should be removed and replaced.

9.4 If single surface treatment is adopted as a viable alternative to maintenance of gravel roads, a comprehensive training program must be developed and maintained.

9.5 The test sections used in the evaluation should continue to be monitored where possible. The indications are that, over a longer time period, the cost of the single surface treatment will be less than the cost of the gravel surface sections.

9.6 Further trials should be constructed to determine whether the performance of the single surface treatments can be enhanced by using a higher rate than the 1.80 kg/m^2 used in these trials.

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APPENDIX

Section 1

Location: Township of Hinchinbrooke Oak Flats Road - Lot 22 & 23, Con. 4

Length: 1.0 km Width: 5.48 m.

Treatment: Single Surface Treatment

Performance

88-10-18: Three small pot holes at the beginning of the test section. Surface treatment is in good condition.

90 09 12: Slight coarse aggregate loss due to streaking at the east end of the test section. Extensive patching for 100 m possibly due to grade problems. Remainder of the surface treatment is in good condition.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 88 10 18	6-8	85	N/A
Date: 90 09 12	6	65	N/A

A satisfactory surface treatment with good coarse aggregate retention. Slight distortion of the road surface did not affect the good riding qualities.

Section 2

Location: Township of Hinchinbrooke Wagarville Road - Lot 24, Con. 6

Length: 1.0 km Width: 6.10 m.

Treatment: Single Surface Treatment

Performance

88-05-11: Pot-holing at rate of 10+ per km. A 400 m section contained severe potholing due to grade failure. This section was re-treated in 1988 prior to the site visit.

90 09 12: Intermittent slight streaking the full length of the test section resulted in slight/medium coarse aggregate loss. Slight + washboarding and distorting has affected the riding qualities of this road.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 88 05 11	-	59	N/A
Date: 90 09 12	4	39	N/A

This road is a good example of surface treatment break-up due to inadequate ditching (drainage) in cuts and side hill cuts. Riding qualities were affected due to distortion, washboarding and patching. The nature of the coarse aggregate loss indicates that it was caused by streaking, a non uniform application of emulsion across the width of the road. This is normally caused by the distributor spray bar set at an incorrect height above the road surface.

Section 3

Location: Township of Hinchinbrooke Wagarville Road - Lot 24, Con. 7

Length: 1.0 km Width: 4.88 m.

Treatment:
87 09 04 Black Liquor was used as the dust suppressant.
88 04 28 Treated with flake and liquid calcium chloride.
1989 Double Surface Treatment.

Performance:
This section received a double surface treatment as part of the Township's 1989 surface treatment program. It is no longer useful as a test section for dust suppressant.

Summary: Field performance evaluation is not possible for this test section.

Section 4

Location: Township of Hinchinbrooke White Lake Road, Road Allowance between Lots 10 and 11, Con.1

Length: 1.0 km Width: 4.88 m.

Treatment: Flake and liquid Calcium Chloride was used as the dust suppressant.

Performance
90 09 12 The road surface was well compacted with very little float. The surface appeared damp with no dust from traffic. A good riding surface with intermittent slight rippling.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 90 09 12	5	60	N/A

This test section is a good example of a gravel surfaced road using dust suppressant. A low traffic volume requires minimum of grader maintenance to maintain a satisfactory ride.

Cost Summary for Sections 1, 2, 3 and 4

YEAR	OAK FLATS ROAD	WAGARVILLE ROAD		WHITE LAKE ROAD
	S.S.T.	S.S.T.	D.S.	D.S.
Initial 1987	$7,011.00	$7,358.30	$624.80	$1,521.60
Year 1	-	(2)$5,846.63	(1) $7,712.80	$2,801.61
Year 2	$159.30	$318.60	-	$2,964.82
Year 3	$567.00	$1,539.00	-	$2,410.43
TOTAL	**$7,737.30**	(3)**$7,704.23**	**$8,337.60**	**$9,698.46**
Length (km)	1.0	1.0	1.0	1.0
Cost per km per year	$1,934.33 (4 years)	$2,568.08 (3 years)	$4,168.80 (2 years)	$2,424.62 (4 years)

1. This test section received a double application of calcium chloride in 1988 including cost of $3,470.00 for a granular lift. In 1989, this section was double surface treated so as not to leave a portion of gravel road with surface treatment on either side.
2. This section failed during the winter of 1987-88 and required a single surface treatment in 1988.
3. Does not include the cost of the original surface treatment.

Section 5

Location: Township of Hagarty & Richards Hagarty Road No. 16, West of Highway 62.

Length: 1.1 km Width: 6.7 m.

Treatment: Single Surface Treatment

Performance

88 10 19: Single pot-holes mainly along the centre line of the road at approximately 30 pot-holes/km. In addition, there were several failures approximately 1 x 2 m in size.

90 09 11: Single pot-holes mainly along the centre line of the of the road at approximately 30-40 to the km. Most failures appear in areas where the centre line is depressed. Additional break-up originating at the centre line occurred in poorly drained areas.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 88 10 19	-	67	N/A
Date: 90 09 11	6	55	N/A

A satisfactory surface treatment with good coarse aggregate retention. The road surface is slightly rippled, combined with the patching downgraded the ride to fair-good.

Section 6

Location: Township of Hagarty & Richards Hagarty Road No. 19, East of Highway 62.

Length: 0.9 km Width: 6.7 m.

Treatment: Single Surface Treatment

Performance

88 10 19: Single pot holes at approximately 20 per km mainly along the centre line of road.

90 09 11: Single pot-holes along the centre line of the road. These pot-holes would spread into both lanes often increasing in size. Most of these break-ups would occur in areas of marginal drainage such as shallow ditches or side entrances.

Summary		Riding Comfort Rating (RCR)	Condition Rating	AADT
	Date: 88 10 19	6	72	N/A
	Date: 90 09 11	5	60	N/A

The surface treatment is performing satisfactorily with slight rippling of the surface but the amount of patching indicates some weakness in the grade.

Section 7

Location: Township of Hagarty & Richards Hagarty Road No. 16 - West of Highway 62

Length: 0.5 km Width: 6.1 m.

Treatment: Waste Oil was used as the dust suppressant.

Performance
90 09 11: Road surface had some float from the addition of granular material and grader maintenance. The surface had slight washboarding with little effect on the riding qualities. There was slight dust generated from traffic.

Summary		Riding Comfort Rating (RCR)	Condition Rating	AADT
	Date: 90 09 11	6	55	N/A

A typical gravel road treated with a dust suppressant that is performing satisfactorily.

Section 8

Location: Township of Hagarty & Richards Hagarty Road No. 19 - East Of Highway 62.

Length: 0.5 km Width: 3.65 m.

Treatment: Waste Oil was used as the dust suppressant.

Performance
90 09 11: This road has a cross-section which varies from level to a slightly depressed centre line. There is a slight amount of float and the surface has slight washboarding but the riding qualities still range from fair to good.

Summary		Riding Comfort Rating (RCR)	Condition Rating	AADT
	Date: 90 09 11	5	60	N/A

This test section is performing well.

Cost Summary for Sections 5,6,7 and 8

	Hagarty Rd. #16		Hagarty Rd. #19	
	S.S.T.	D.S.	S.S.T.	D.S.
Initial - 1987	$16,123.91	(2) $5,405.50	$13,206.09	$887.25
Year 1-88	$409.90	(1) $90.00	$309.10	(1) $90.00
Year 2-89	$520.00	(1) $100.00	$309.00	(1) $100.00
Year 3-90	$820.00	$1,055.00	$842.00	$699.00
Total	$17,873.81	$6,650.50	$14,666.18	$1,776.25
Length - km	1.1	0.5	0.9	0.5
Cost per km per year	$4,062.23 (4 years)	$3,325.25 (4 years)	$4,073.94 (4 years)	$888.13 (4 years)

1. Dust suppressant was not applied in 1988-89.
2. Cost included $3,922.75 for a granular lift prior to the application of the dust suppressant.

Section 9

Location Town of East Gwillimbury Holborn Road - Con. 7 to Highway 48.

Length 2 km Width 6.75 m.

Treatment Single Surface Treatment

Performance

88 06 28 Single pot-holes approximately 0.3 m in diameter occurring at an average rate of 15 per km.

90 09 14 Due to the failure of the single surface treatment during the spring break in 1990, another single surface treatment was applied in May 1990. The new surface treatment used a Granular "A" gradation of stone which resulted in the oversize stone being lost due to traffic. The remaining oversized stone affected the riding qualities of this road.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 88 10 19	6	72	-
Date: 90 09 14	4	59	315

The use of a surface treatment aggregate with oversize stone has affected the riding qualities and contributed to the loss of some of the large stone particles.

Section 10

Location Town of East Gwillimbury Holborn Road, Con. 6 to 7.

Length 2.0 km Width 6.75 m.

Treatment Liquid Calcium Chloride was used as the dust suppressant.

Performance

90 09 14 There is intermittent shallow pot-holing along the centre line of the road and in the outer wheel tracks. The ride is satisfactory except in the pot-holed sections.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 90 09 14	3	N/A	275

This section may not be receiving sufficient grader maintenance for the traffic volume on this road. This could result in additional pot-holing of the remaining smooth surface.

Cost Summary for Sections 9 and 10

	Holborn Rd.		Holborn Rd.	
	SST	D.S.	SST	D.S.
Initial - 1987	$20,679.09	$1,287.11		
Year 1	$365.05	(1)$10,379.96		
Year 2	$1,230.08	$2,398.94		
Year 3	(2)$19,666.46	(3)$11,506.54	Three Year Cost	
Total	**$41,940.68**	**$25,572.55**	**$22,274.22**	**$14,066.61**
Length/km	2.0	2.0	2.0	2.0
Cost per km per year	$10,485.17 (4 years)	$6,393.14 (4 years)	$3,712.37 (3 years)	$2,344.33 (3 years)

1. Including $7,173.00 for a granular lift.
2. The original surface treatment failed in the spring of 1990 and was replaced with a single surface treatment in June 1990. This cost included $7,686.00 for a lift of granular prior to surface treating.
3. This section required a granular lift costing $7,686.00 prior to the 1990 application of dust suppressant.

Section 11

Location a) Town of Newcastle, Con. Road 10, Best Road to Hwy 35.
b) Town of Newcastle, Con. Road 10, Mosport Road easterly

Length a) 2.0 km Width 7.3 m
b) 0.55 km Width 7.3 m

Treatment Single Surface Treatment

Performance

88 05 26 Slight potholing at a rate of 4 per km. The overall condition of the road is good.

90 09 13 The surface treatments used a larger size aggregate, probably a Granular "A", which resulted in some larger stone loss and contributed to a noisy ride with vibration. Cold mix patching averaged 15 per km.

Summary		Riding Comfort Rating (RCR)	Condition Rating	AADT
	Date: 88 05 26	-	79	60 (1985)
	Date: 90 09 13	5	59	

The use of larger stone for the surface treatment aggregate affected the riding qualities and caused some of the larger stone particles to whip off.

Section 12

Location Town of Newcastle, Con. Road 10, 2.0 - 3.05 km west of Jct. Hwy. #35.

Length 1.05 km Width 6.1 m.

Treatment Flake calcium chloride was used as the dust suppressant.

Performance
90 09 13 There is a slight amount of loose coarse aggregate across the road surface. Slight washboarding in the wheel tracks reduces the riding qualities to fair. The road surface appeared damp and there was no dust raised by traffic.

Summary		Riding Comfort Rating (RCR)	Condition Rating	AADT
	Date: 90 09 13	4	40	58 (1985)

This section is performing satisfactorily.

Cost Summary for Sections 11 and 12

	Conc. Road #10	
	SST	DS
Initial Year 87	$23,694.40	$650.00
Year 1	$40.00	$322.00
Year 2	$90.00	$355.00
Year 3	$100.00	$400.00
Total	**$23,924.40**	**$1,727.00**
Length/km	2.55	1.05
Cost per km per year	$2,345.53 (4 years)	$411.19 (4 years)

Section 13

Location Township of Glanbrook Kirk Road West, Trinity Church Road to Fletchers Road

Length 1.1 km Width 6.5 m.

Treatment Single Surface Treatment

The surface treatment was applied on July 6th, 1987 using HF-150S emulsion and a Granular 'A' gradation of aggregate. The aggregate was poorly graded with a quantity of oversize aggregate in the 25 - 50 mm range. In addition, the Municipal inspector/supervisor noted that, in his opinion, the aggregate was excessively dirty. The oversize stone picked out during the winter of 1987/88 leaving holes in the surface which enlarged into extensive pot holing eventually leading to the failure of this section.

In 1988 another single surface treatment was applied using HF-RS2 emulsion and Class 1 aggregate. Grade preparation included the filling of the pot-holes with granular prior to the application of the surface treatment.

Performance

88 05 17 This section had an average of 22 single pot-holes per km. There are additional break ups averaging 1 m to 8 m in size at a rate of 9 per km. Riding qualities varied from fair to good.

90 09 17 The surface treatment aggregate used appeared to be mostly 9.5 mm in size. The smaller stone resulted in a tight surface texture in the wheel paths. The road surface was slightly distorted with some wheel track rutting. There was considerable machine patching of the road surface which makes it difficult to determine the amount of actual break-up.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 88 05 17	6	50	-
Date: 90 07 17	5	50	350

This surface treatment was applied in 1987 but failed because of the oversized aggregate used. A single surface treatment was re-applied in 1988 and appears to be performing satisfactorily with a minimum of maintenance.

Section 14

Location Township of Glanbrook Haldibrook Road, Tynside Road to Con. 8, Lot 7.

Length 2.7 km Width 7.0 m.

Treatment Liquid Calcium Chloride was applied in 1987 and 1988.
A double surface treatment was applied in 1988.

This test section performed well but was upgraded with full reconstruction and an application of a Double Surface Treatment in 1988 as part of a road improvement program.

Performance

90 09 17 A uniform surface with good riding qualities.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 90 09 17	7	80	175

This road is no longer useful for evaluation as a dust suppressant test section.

Cost Summary for Sections 13 and 14

	Kirk Road SST	Haldibrook Road DS
Initial Year 87	(1) $26,920.35	$1,580.00
Year 1	(2) $10,330.88	$3,421.41
Year 2		(4) $3,307.82
Year 3	$2,357.75	3,347.68
Total	(3) **$12,688.63**	**$11,656.91**
Length/km	1.1	2.7
Cost per km per year	$3,845.04 (3 years)	$1,079.34 (4 years)

1. This total includes $16,717.12 for additional granular material required for base preparation.
2. This sum was spent for a SST application using HF-RS2 in 1988 to replace the original surface treatment that failed in the winter of 1987-88.
3. This total cost does not include the cost of the original surface treatment applied in 1987.
4. A double surface treatment was applied in 1988 on this dust suppressant test section as part of a road improvement program. Year 2 and Year 3 maintenance costs were therefore estimated.

Section 15

Location: Town of Caledon 1st Line East, 25th Side Road to Highway 9.

Length: 2.5 km. Width: 7.0 m.

Treatment: Single Surface Treatment

Performance

88 06 28 Multiple potholing up to 18 per km. Major base failures 0.4 per km.

90 08 28 Extensive patching mostly in areas with shallow ditching or side hill cuts throughout this section. There is some distortion of the road surface which, combined with the patching, downgrades the ride to fair.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 88 06 20	4	41	170 (1984)
Date: 90 08 17	3	35	

This surface treatment failed in 1987-88 and a single surface treatment was re-applied in 1988. This section requires extensive patching each year in areas of poor drainage.

Section 16

Location: Town of Caledon 1st Line East, 20th Side Road to 25th Side Road.

Length: 3 km Width: 7.0 m.

Treatment: Liquid Calcium Chloride dust suppressant applied annually.

Performance
90 08 28: Slight washboarding in both lanes. There is slight-medium coarse aggregate float forming a small windrow. The ride is generally fair-good.

Summary

	Riding Comfort Rating (RCR)	Condition Rating	AADT
Date: 90 08 28	4		170 (1984)

This test section is performing well as a gravel road using a dust suppressant.

Cost Summary for Sections 15 and 16

	1st Line East SST	1st Line East D.S.
Initial Year 87	$14,542.38	$3,867.10
Year 1	(1) $22,500.00	$2,793.00
Year 2	(2) -	$2,793.00
Year 3		$2,793.00
Total	**$22,500.00**	**$12,243.10**
Length/km	2.5	3.0
Cost per km per year	$3,000.00 (3 years)	(3) $1,020.26 (4 years)

1. The surface treatment applied in 1987 failed due to excessive pot-holing and break-up. It was replaced in 1988 at a cost averaging $9,000.00 per km.
2. There are no accurate maintenance costs available for this test section.
3. This cost is based on the average 1990 cost per km to maintain a gravel road surface including dust suppressant.

FIGURES

FIGURE 1

SINGLE SURFACE TREATMENT TRIAL FOR DUST CONTROL ON GRAVEL ROADS

Municipality _____ Date _____

Road _____ Length _____ km

Location _____ Width _____ m

Traffic Count (AADT) _____

1. Preparation of Base (3)
   Crushed Gravel: Quantity _____ tonnes
   Cost $ _____

2. Single Surface Treatment
   Date _____
   Quantity HF-250 S _____ kg
   Quantity Class 2 Aggregate _____ tonnes
   Cost $ _____

3. Surface Treatment Maintenance

87 06

Activity (1,4)	Year			
	1987	1988	1989	1990
Spray Patching, m^2				
Spray Patching Cost, $				
Cold Mix Patching, t				
Cold Mix Patching Cost,$				
Patching Other, ___				
Patching Other Cost,$				
Misc. Work (2)				
Misc. Cost, $				
TOTAL				

Notes: (1) The recording of activities should begin after the surface treatment in 1987 and end on November 1st., 1990.

(2) To include activities such as grading areas of broken surface treatment. Should not include ditching or brushing, etc.

(3) Grading costs prior to the single surface treatment should not be included.

(4) Administration costs should not be included.

FIGURE 2

DUST SUPPRESSANT TRIAL

Municipality _____ Date _____

Road _____ Length of Dust Layer _____ km

Location _____ Width of Dust Layer _____ m

Traffic Count (AADT) _____

Dust Layer:

ITEM (5)	1987	1988	1989	1990
Type (1)				
Date 1st. Application				
Date 2nd. Application				
Cost 1st. Application				
Cost 2nd. Application				
Grading (2), hours				
Grading Cost (2), $				
Misc. Work (3)				
Misc. Cost (3), $				
Crushed Gravel (4), t				
Crushed Gravel Cost, $				
TOTAL				

Notes:

87 06

(1) Please indicate the type as follows: Liquid Calcium Chloride,LC; Flake Calcium Chloride, FC; Waste Oil, WO; Natural Brine, NB; Lignosulphonate, L; Other , please specify.

(2) Should include all grading to the trial roadway beginning after the first application of dust layer in 1987, and ending November 1st., 1990.

(3) For extra work not included above, eg. spot application of flake calcium in front of houses, etc.

(4) The recording of all items should begin in 1987 after the 1st. application of dust layer and end on November 1st., 1990.

(5) Administration costs should not be included.

Surface-treated Pavement Condition Evaluation Form

Location From _____ To _____

LHRS ☐☐☐☐☐ BEGINS ☐☐.☐ km OFFSET

Section Length ☐☐.☐ km LENGTH

District ☐☐

Highway ☐☐☐☐

Survey Date ☐☐ YEAR ☐☐ MONTH

PCR ☐☐☐ RCR ☐.☐

Contract No. ☐☐-☐☐☐

WP No. ☐☐☐☐-☐☐-☐☐☐

Traffic Direction ☐

B: Both Directions
N: North Bound
S: South Bound
E: East Bound
W: West Bound

Riding Comfort Rating (At Posted Speed)

Excellent	Good	Fair	Poor	Very Poor
Smooth and Pleasant	Comfortable	Uncomfortable		Rough and Bumpy

Pavement Distress Manifestation			Severity of Distress			Density of Distress % Extent of Occurence		
			Slight	Moderate	Severe	Intermittent	Frequent	Extensive
			1	2	3	<20 1	20-50 2	>50 3
Surface Defects	Loss of Cover Aggregate	1						
	Streaking	2						
	Flushing	3						
	Pot Hole	4						
	Pavement Edge Break	5						
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7						
	Distortion	8						
Cracking	Longitudinal	9						
	Transverse	10						
	Pavement Edge	11						
	Alligator	12						

Shoulder Distress	Density of Distress % Extend of occurence			
	Right		Left	
	10 - 30	>30	10 - 30	>30
	1	2	1	2
Encroaching Growth				
Poor Crossfall				

Maintenance Treatment for Pavement	Extent of Occurence %		
	<20	20-50	>50
	1	2	3
Manual Patching			
Machine Patching			
Manual Spray Patching			
Manual Chip Seal			
Machine Chip Seal			
Fog Seal			
Manual Burn & Seal			

Distress Comments (Items not covered above) _____

Other Comments (e.g. subsections, additional contracts) _____

Evaluated by: _____

FIGURE 3

FIGURE 4

A Guide for Estimation of Pavement Condition Rating and Associated Maintenance Rehabilitation Strategies for Surface-treated Roads.

Pavement is in excellent condition with just a few bumps or depressions from slight surface deformation. No surface defects such as streaking, potholes or cracking distresses. Ride is very good (8 - 10)	80 - 100	Routine maintenance.
Pavement is in good condition with just a few bumps or depressions from slight to moderate surface deformation. Intermittent slight to moderate surface defects and/or cracking distresses. Ride is good (6 - 8)	60 - 79	Corrective maintenance on an annual basis or sooner when necessary.
Pavement is in fair condition with intermittent to frequent bumps or depressions from slight to moderate surface deformation. Intermittent to frequent moderate surface defects and/or cracking distresses. Ride is fair (4 - 6)	40 - 59	Corrective maintenance to hold serviceability level on a semi-annual basis or sooner when necessary. May be candidate for major corrective maintenance as holding strategy depending on performance level and history. Candidate for rehabilitation program in 3 to 5 years.
Pavement is in poor condition with frequent bumps or depressions from moderate surface deformation. Frequent moderate to severe surface defects and/or cracking distresses. Localized slight to moderate alligatoring crack may be present indicating pavement structural failure. Ride is poor (2 - 4)	20 - 39	Corrective maintenance to retard rapid deterioration of serviceability level. Candidate for rehabilitation program in 1 to 3 years.
Pavement is in very poor condition with extensive bumps or depressions from moderate to severe surface deformation. Extensive to severe surface defects and/or cracking destresses. Frequent slight to moderate alligatoring may be present, indicating pavement structural failures. Ride is very poor (0 - 2)	0 - 19	Corrective maintenance when and where necessary to maintain minimal safety and serviceability level. Rehabilitation within 1 year.